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From STEM to STEAM: *Integrating Arts Education into the STEM disciplines of Science, Technology, Engineering and Math*

By:

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Abstract

This thesis explores the current educational trend of integrating the arts into the STEM curriculum (Science, Technology, Mathematics and Engineering). This thesis uses research, interviews and surveys of educators, educational administrators, STEM professionals and lay people to discuss the role the arts play in fostering creativity and innovation in the area of STEM education as well as where the arts fit into the core curriculum. Using these methodologies, this thesis explores the relationship between the study of the arts and success in STEM and other disciplines and how these relationships may affect the 21st century learner as they prepare for their professional lives. The studies conducted for this thesis may have a broader impact on setting local and state policy on requiring arts integration into other non-arts related subjects.

Contents

Acknowledgements

Thank you to:

- Dr. Brad McLain for your insights
- Dr. Dennis Wint for your sage advice
- Dr. Andrew Zitcer for getting me started on the path
- Friends and colleagues who supported me in this effort

Dedications

- For my wife Ranelle and kids, Ian and Zane who finally get to see their Dad again!
- For my Mom and Dad – I know you would be proud!
- For my sisters: Dr. Carla Maltas and Karen Moore – thanks for all the encouragement!
- For Berniece Luthy – thanks for your support too!

"A broad education in the arts helps give children a better understanding of their world… We need students who are culturally literate as well as math and science literate." – Paul Ostergard, VP Citicorp

'It's in Apple's DNA that technology alone is not enough-it's technology married to the liberal arts, married to the humanities that make our hearts sing." – Steve Jobs, CEO Apple

PURPOSE

For many years, there has been much discussion about promoting the disciplines of Science, Technology, Engineering and Math (collectively known as STEM) in all levels of education. It has become an issue facing many in higher education and in companies that hire those with STEM backgrounds as many jobs go unfilled due to a lack of qualified workers (Bidwell 2014). As a political issue, President Obama himself put the focus on the STEM disciplines with his *Educate to Innovate* initiative (White House 2009). Because of this focus in the United States of keeping up with the rest of the world when it comes to these core subjects, it is often the other subjects seen as "extraneous," that are the first to receive higher scrutiny when the budget axe begins to swing. This often includes the arts in its many forms.

The purpose of this thesis is to investigate the question of whether professionals in working in the Arts and STEM fields view the current arts integration debate as being critical to fostering creativity and innovation in their own disciplines and if non-educators from a select survey group who are concerned with education view the integration of arts and STEM as necessary.

Arts educators and administrators often find themselves in the position of having to defend the arts and their place in curriculum as well as society to lawmakers, potential donors, and sometimes other administrators. Advocates for the arts argue that the arts are not only critical but central to a complete and well-rounded education. The argument for integrating the arts into STEM (called STEAM or STEM + Arts by those who advocate for this approach) is that integration is necessary not only for creativity and innovation, but also that it may improve our standing on the world stage and bring our country to the forefront of advancement in these disciplines as well (Beal 2013). Indeed the link between creativity and technology is on the increase as many technology companies look for higher order problem solving skills and high concept design when issuing new products. Google, for example is famous for conducting interviews with open-ended questions that are designed to show not only what a job candidate knows, but how well that candidate might think on their feet and collaborate creatively with their co-workers (Levetin 2014). Many technology companies are also using new and inspiring ways to get their employees to think "outside the box," from Microsoft holding employee "Science Fairs," to IBM's "Jams," to Google's famous "20-percent time" (Bort 2013). All of these companies use an artistic method to influence the creation of new technology or improvements to existing technology. It is from these breakout sessions that many great innovations have come. For example, a 3-M employee used their "15% time," (which preceded Google's 20% time by many years) to apply a failed adhesive to the back of a piece of paper which became 3-M's most famous product: the Post-It Note (Bort 2013).

Hypothesis:

- Surveyed professionals who work in the fields of the STEM disciplines also have strong arts education backgrounds in either visual arts, music, or theater (or any combination of those disciplines).
- Those who work in the STEM disciplines see their arts experience as important in personal and professional development.
- A high percentage of survey takers who work in the STEM fields are still active in the arts, whether as consumer or producer.
- Many people in the arts disciplines would like to see the arts integrated with the disciplines of science, technology, engineering and math as well as to the common core.
- Cross-curricular integration of the arts and STEM will lead to a higher quality educational experience for our students and will help to enhance creativity and innovation.
- Non-educators who take the survey would view the integration of Arts and STEM as necessary to foster creativity and innovation as well.

Methodology

The research process for this paper includes reviewing existing literature including scholarly articles, books, and government papers and reports as well as conducting interviews and surveys with people who are currently active in the STEM disciplines, many of whom are

colleagues that I have worked with on past projects. Using their influence and through interpersonal networking, I also conducted interviews with people in both the arts and the STEM disciplines to determine what their perception is on whether the arts may help to foster creativity and innovation in their own content area, be it science, engineering, math or technology. Information was gathered from each study participant or interviewee to discern what effect, if any, the arts played in their career choice or field of study as well as what influence the arts still carries in their daily lives (whether they are still active in the arts in one way or another) and how they perceive creativity as a necessary function of what they do both personally and professionally.

In order to gain a better perception on professional opinion of STEM + the Arts a survey was constructed comprised of 21 questions that included multiple choice, ratings, and essay questions. The survey sample size was 236 recipients of which 67 responses were received for a penetration rate of 28%. The participants in the survey sample came from multiple professions and age ranges and included multiple disciplines from STEM and the Arts were represented as well as participants who perceived themselves as not being part of either area of study. The people who identified themselves as being non-STEM or non-Arts respondents were 35% of the total survey sample. Of the non-STEM, non-arts respondents, 58% of those who identified themselves as "Other," were professional educators or administrators from different disciplines that were not STEM or arts related.

In the construction of this thesis, the biggest limitation was creating a sample size that was representative of all of the demographic groups that I wished to research. The survey sample

was created largely from colleagues and friends of the author with the possible expansion to some of their colleagues and friends who share the same interest in the subject matter. This may have created a biased sample that leaned heavily toward pro-arts integration or making the arts a core subject without the time or resources to explore the other side of this argument. By expanding the sample size and incorporating a more widely varying sample of professionals in the STEM fields, a more accurate picture may emerge with regards to opinions on arts integration into core subjects including the STEM disciplines.

This study is not intended to advocate for STEAM. Many of the scholarly articles and other sources gathered are primarily for just that purpose. Rather, I intend to assess and evaluate current trends in the STEM disciplines and how creativity and innovation are a part of the daily lives of those who work in their respective fields. I will be measuring how much of an arts background an interviewee or survey taker has as well as whether they perceive that arts education has helped them in their core field of study. I also intend to gain new insights from those professionals working in the STEM fields as to how best to integrate arts curriculum and STEM curriculum in such a way that will provide a positive experience for the 21st century learner in either discipline.

Another challenge in creating this study was having enough quality interview subjects/survey takers from each respective discipline. Besides using the circle of influence of the researcher, various professional organizations were contacted to identify and select members that were able to be used as survey takers. Given this somewhat impersonal approach to creating and distributing this survey, the penetration/completion rate was 28%. Dr. Brad McLain, co-director at X-Sci, Experiential Research Collaborative at the University of Colorado, Boulder also gave

opinions on this topic and provided the researcher with scholarly articles that were used in the creation of this thesis.

Literature Review

There is little doubt that arts integration into STEM education is currently one of the prominent topics in the world of arts education. Existing literature has seen a gradual positive shift in the argument for incorporating arts education into STEM learning in recent years. The dichotomy of necessity vs. frivolity, and integration vs. enhancement are some of the chief concerns that arise when it comes to the topic of how best to bring the arts into STEM education. The biggest part of the ongoing debate now seems to be framed around how best to foster creativity and innovation by utilizing the arts and the arts mindset when approaching objective subjects such as math, science or technology. Much of the literature that is currently available on this topic offers a wide variety of opinions on how to bring together two sets of disciplines that seemingly use different thought processes and learning capacities to achieve their goals.

Where STEM came from and where it is headed

In the 1990's, the National Science Foundation (NSF) began using the term "SMET," as an acronym to represent "Science, Math, Engineering, and Technology." After one of the officers of the organization complained the "SMET," sounded too much like "SMUT," the STEM acronym took its place (Sanders 2009). Even after the adoption of this new acronym, differentiation was never made between whether STEM refers strictly to education (its most

common use) or the actual disciplines themselves and the professionals who work in those disciplines (Sanders 2009). In many professional and government documents throughout the late 1990's and early 2000's, STEM education and STEM initiatives became the focus of many studies which advocated for closing the perceived gap in the American educational system where STEM education was concerned (Congress 2011). Then in November 2009, President Barack Obama introduced his *Educate to Innovate* initiative (White House 2009) in which the President's Council of Advisors on Science and Technology summarized the current gap in technological education in America's schools. Most alarmingly, this report highlighted the educational gap in underrepresented cultural groups in STEM education, as well as the lack of women and exceptional role models. The goals of this initiative are to improve the quality of STEM education by bringing the CEO's of major companies together to create a mentorship program for K-12 students and to certify 100,000 teachers on the importance of STEM education and how to incorporate this learning into their classrooms.

While the President's initiative is of high importance, what is never mentioned in the report is the need for creative outlets for students involved in STEM education. The creativity gap has been noted not only in education, but also in the workplace where 1 in 4 people do not feel they are living up to their creative potential at work, and the pressure to be *productive* at work rather than be *creative* is ever on the rise (Adobe Create 2012). It is not too surprising given the creativity gap brought to light by this report that little emphasis is given to creative disciplines in STEM education. Yet 76% of Americans surveyed believe that creativity is valuable to society and the key to driving economic growth (Adobe Create 2012).

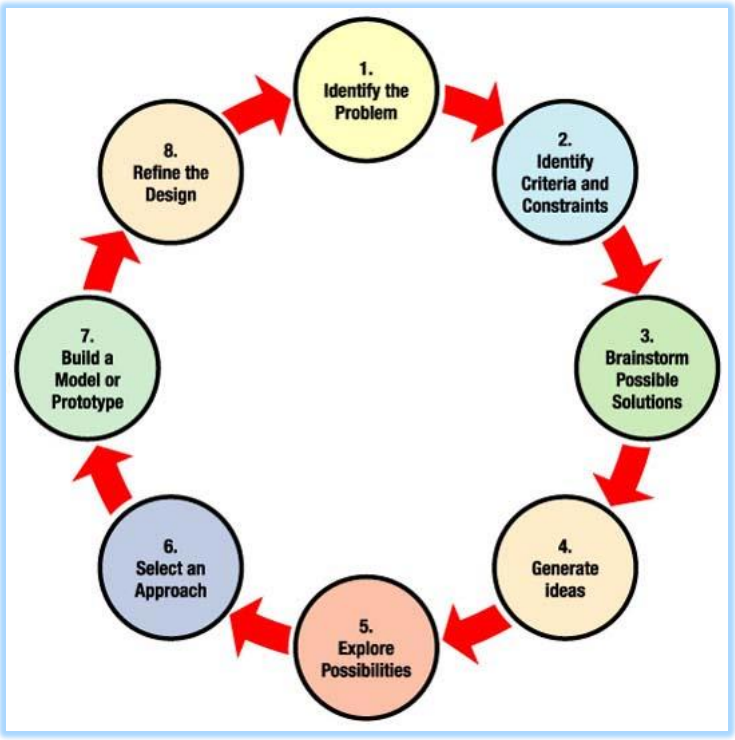
As underserved communities and the gender gap continues to widen, many school districts are investigating how to increase interest in STEM-oriented classes. For example, the Cleveland School District started the MC^2 STEM School in 2011. One-hundred percent of students in this district are on free or reduced lunch. Within five years of launch of the MC^2 STEM School, graduation rate at this particular Cleveland school stood at 95% in a district that saw only 60% graduation rate throughout the rest of the district (Vega 2012). By partnering with major technology firms to give students real-world applications for their projects, and by integrating creative writing and computer and graphic design into their capstone projects, the Cleveland School District saw greater success in retention and graduation rates. In other words, by bringing creative focus and the arts into STEM applications, the Cleveland School District demonstrated a marked improvement in many of its core student success metrics.

The case for Arts Integration

Much of the current literature written about the subject takes a positive stance on the need for arts integration into the STEM disciplines citing the need not only for more people entering the STEM sectors and more technologically oriented jobs, but also for those students to be creative and innovative once they are working in the STEM fields as well. As a positive example, Michigan State University did a study of STEM field graduates from 1990-1995 and found that of those graduates, the ones who held patents or had started their own businesses had eight

times more exposure to the arts as children as their colleagues who had less arts exposure (Brady 2014). Another study notes the similarity in the design process between the visual arts and engineering noting that “Art, like engineering, is concerned with finding answers to problems and seeking visual solutions using the design process,” (James Bequette 2012). When one looks at the design process currently used by NASA, one can certainly see how many of those elements could be translated into a visual arts project (Figure A):

Figure A: NASA Design Process



Some in the arts community will argue that by applying a rigid structure to the planning of art, it takes away the creativity and spontaneity inherent in the creative process. However, one might argue that even the Mona Lisa as we know it today is possibly a third or fourth draft.

Another of the biggest concerns that is usually brought up when discussing STEM education is the gap in the "education race," between the US and its peers. In October, 2013, a study was released that ranked the United States 21st out of 23 countries in math and science and 17th out of 19 in the area of problem solving (Beard 2013). Because of this lack of educational initiatives, approximately 2.5 million jobs in the STEM sectors will go unfilled in the next 20 years (Doss 2013). As a country used to being in the forefront of innovation and the production of new technologies, how have we fallen so far behind our peer nations in 21st century educational practices? Steve Olsen and Jay Labov cite the extreme diversity of learning systems in the United States as one potential hindrance to creating a mainstream approach to STEM learning. Given the layers of outside influence that surround individual learners such as family, friends, culture, the internet, sports, and church to name a few, it sometimes becomes difficult to break barriers and social norms that would naturally lead students to excel in the STEM disciplines (Labov 2014). The same may also be said of certain art forms trying to break through cultural boundaries vying for student's attention as they work in their other studies. Using music as an example, there are certain cultures (i.e. Louisiana, Appalachia) where music is often taught in the home from an early age. Since the students have grown up with the sounds of Zydeco, or bluegrass in their ear, why should they study the music of long-dead composers that have nothing to do with their cultural context?

When it comes to the integration of the arts into the STEM disciplines, there are many opinions on how best to approach the educational process. Most STEM educators advocate for actual

integration of the arts into STEM teaching as opposed to separating into two content areas. This is not easily accomplished as noted by Sir Ken Robinson:

"One of corollaries on the rise of science has been a schism between the arts and sciences. The sciences are thought to be all about truth and objectivity: the arts about feelings and creativity." (Robinson 2012)

Science often takes creativity when testing new theories, and in art lies great objectivity. Blending two disciplines that seem at first to be far apart, takes great effort and creativity on the parts of the educators. A good reason to advocate for integration is that "integration is (nothing more than) an avenue to facilitate meaning," (Riley, Pivot Point: At the Crossroads of STEM, STEAM and Arts Integration 2013). By integrating two content areas, we ensure that each must be given equal weight and should be assessed with equal intention. As we move toward integration of the arts into STEM, too often the arts are used for enhancement as opposed to true integration. In other words, many teachers might use the arts to demonstrate a concept rather than actually using the arts to clarify and enhance the learning (Ibid.). Thus, a strong specialist in arts integration would be useful in most schools hoping to improve the quality of their STEM curriculum.

The question becomes: why push for arts integration into core subject areas? Why should we not be happy with the way we have always structured our education system? Current research suggests that our educational system as it stands today is set up for 20th century industrial needs. Our education system has traditionally been designed like assembly lines and emphasizing conformity and linearity. The needs of 21st century learners will depend on their

ability to be creative, to be resourceful and to innovate (Jim O'Neill 2014). A 2010 survey of major corporation CEO's asked them what the most important characteristic they looked for in new hires. Over 1500 came back with a one word answer: creativity (Ibid.). Creating students who are imaginative (e.g. theater or art), collaborative (e.g.band or choir), who have ingenuity (like in engineering or industrial technologies) or are creative (like in all areas of arts education) are the students who have the potential to become the leaders of business and innovation tomorrow (Grant 2013).

The Case against STEM + Arts

Because of current educational trends leading toward fostering creativity and higher-order thinking, there is very little literature that expressly speaks out against integration of the arts into STEM education. General public opinion states that we need to be better in not only teaching students how to be creative, but also in allowing our current work force to bring more creativity into their jobs as well (Adobe Create 2012). A positive example of this is Pixar Studios. Pixar is widely known in the entertainment industry for creating over 10 successful motion pictures in a row – a standard that is unmatched by their peers. One of their secrets of success is that they listen to their employees and allow anyone to pitch an idea from the CEO to the person who cleans up at the end of the day (Catmull 2014). This sort of empowerment has led to what is considered by many to be the most creative company working today. They are also not alone in this endeavor. Companies like Yahoo, Google, Zynga and Asana recognize the

benefits of trusting their employees with everything from extraordinary perks to think tanks to unlimited vacations.

Yet STEM+Arts (or STEAM) integration is not without debate. While some educators view the "outside-the-box," thinking that STEAM would invite, there are those who view the inherent difference between the two types of thought processes as too difficult to surmount. "In order to facilitate true collaboration," one scholar writes, "one must recognize the systemic differences between research processes and norms in hard sciences and the arts," (Tymas-Jones 2014). Disparity happens due to the fact that artists are often not seen as true collaborators within the scientific process. Artists are relied upon for visual imagery of data, but not in gathering or coding data. They are also often brought in too late in the collaborative process to have any meaningful input, instead being relied upon to put the "finishing touches," on a project.

Even the STEM disciplines themselves, especially science, is not immune to outside influence from social and religious external forces. An excellent comparison to what is happening in our current social and economic climate is in noting the similarities between now and the Renaissance as explained by Henry Doss:

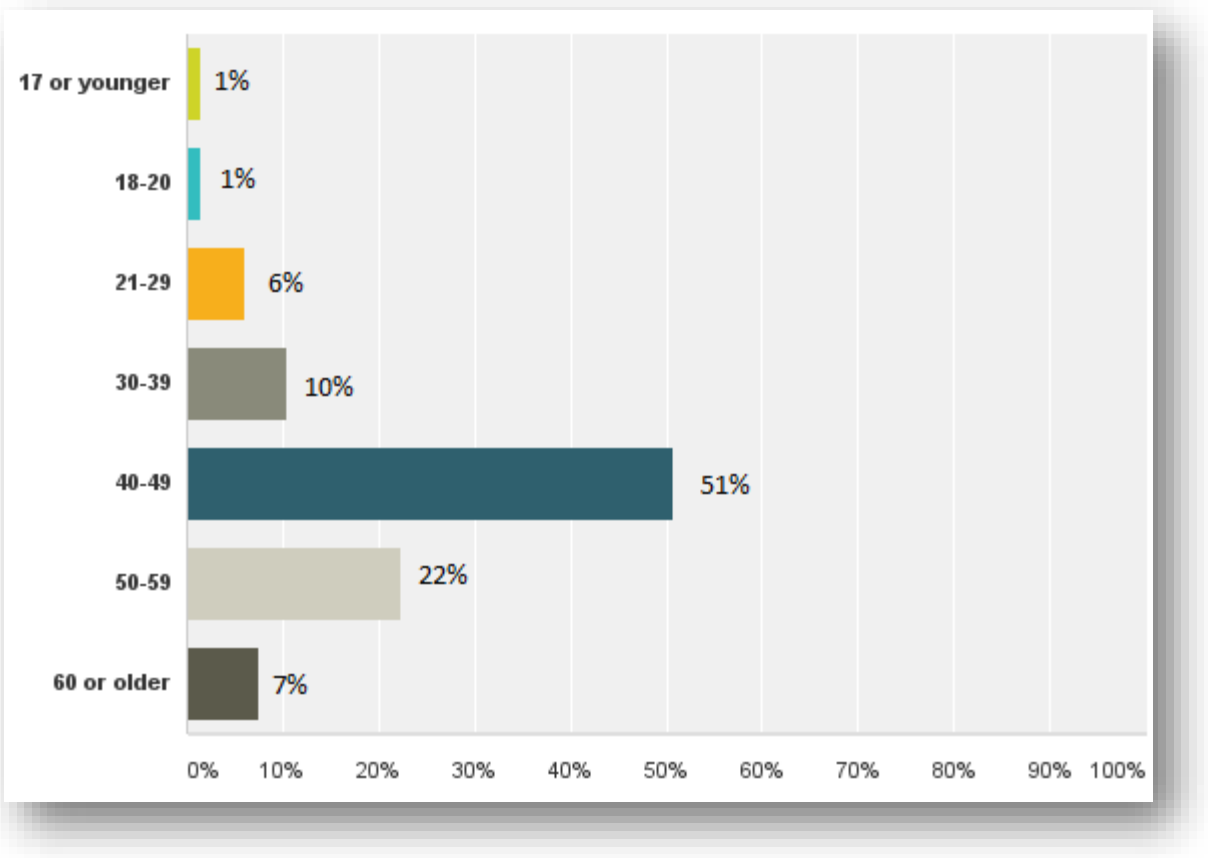
"In the Renaissance (you know, the "real one," a few hundred years back) there was a surge of disruptive technologies, cultural upheaval, profound religious and social conflict, and a dizzying rise in the dominance of science-based thinking. The result was arguably the most innovative period in all of human history. The core curriculum for study during this period was some mix of the guadrivium *(arithmetic, geometry, music and astronomy) and* trivium *(grammar, logic and rhetoric), a very heavy dose of theory-based study of language, math and what we rather offhandedly refer to today as "critical thinking."* (Doss 2013)

With “climate change deniers,” and “anti-vaxxers,” and even the Texas School boards who want to take evolution theory out of state science textbooks largely on religious grounds, we are living in another period of great social and cultural upheaval with the fate of the STEM disciplines potentially in the crosshairs. While the STEM disciplines are seen by most as necessary and important to remain competitive in the world market, a small but vocal faction is doing all it can to slow this technological Renaissance down. To them, the infusion of arts into the core curriculum may seem necessary only “to placate the liberal arts folks,” (Tymas-Jones 2014). But to those whose passion lies in stirring creativity and driving innovation, arts integration is where 21st century education will thrive.

Survey Demographics

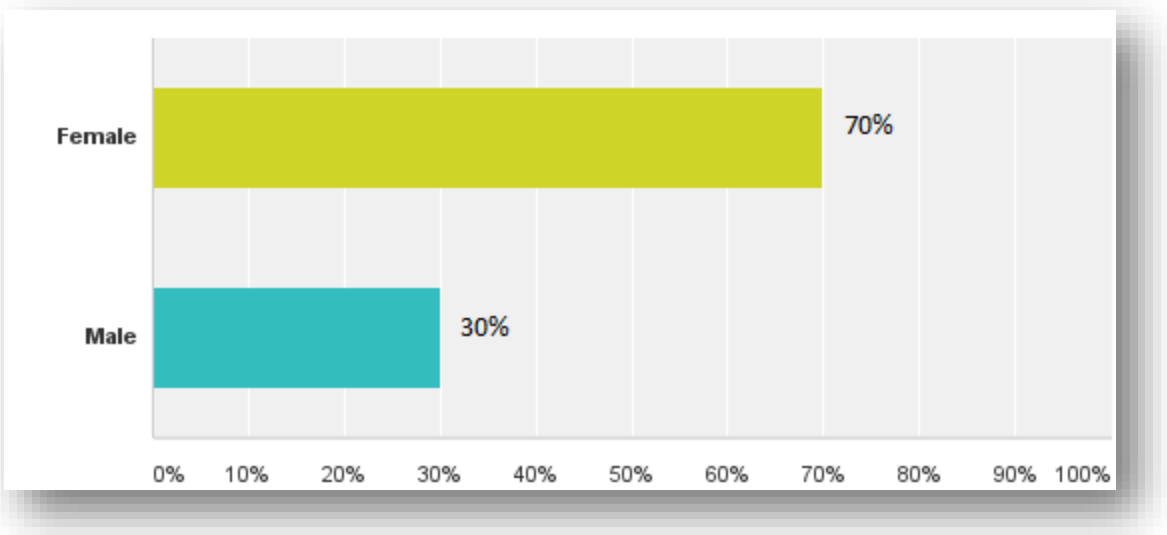
This survey *(refer to Appendix A*) was designed to discover the respondent’s attitudes toward STEM education as well as the integration of the arts into STEM education. The survey link was sent electronically to numerous professionals in the education and STEM fields and was then shared by those professionals with colleagues and in some cases friends and relatives. The results received depict not only those in STEM and arts fields, but also certain members of the general public including students and community professionals. The largest age group fell between 40 and 59 indicating that most colleagues who took the survey fall into the same age range as the author, presumably due to being within the author’s professional network of colleagues (Figure B).

Figure B: Age Range of Respondents:



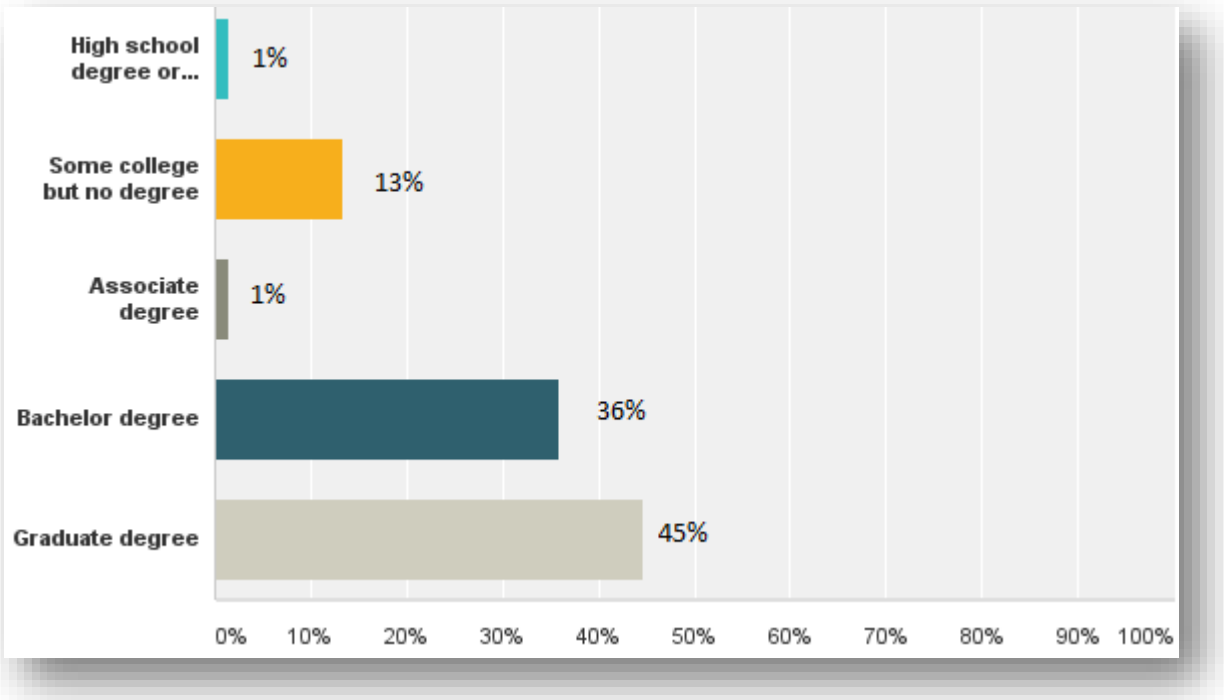
The male/female breakdown of respondents could be due to the large number of educators (mostly K-12 from Nebraska public schools) who were given the opportunity to take the survey. Out of 236 survey requests sent, 165 of the recipients were female (70%) and 71 were male (30%). One-hundred eighty of the total recipients of the survey were involved in the education field in some capacity, either as an educator or administrator. This falls in line with a 2008 study of current educator demographics which indicates that 76% of public school teachers are female (National Center for Education Statistics 2008)(Figure C).

Figure C: Gender of Respondents:



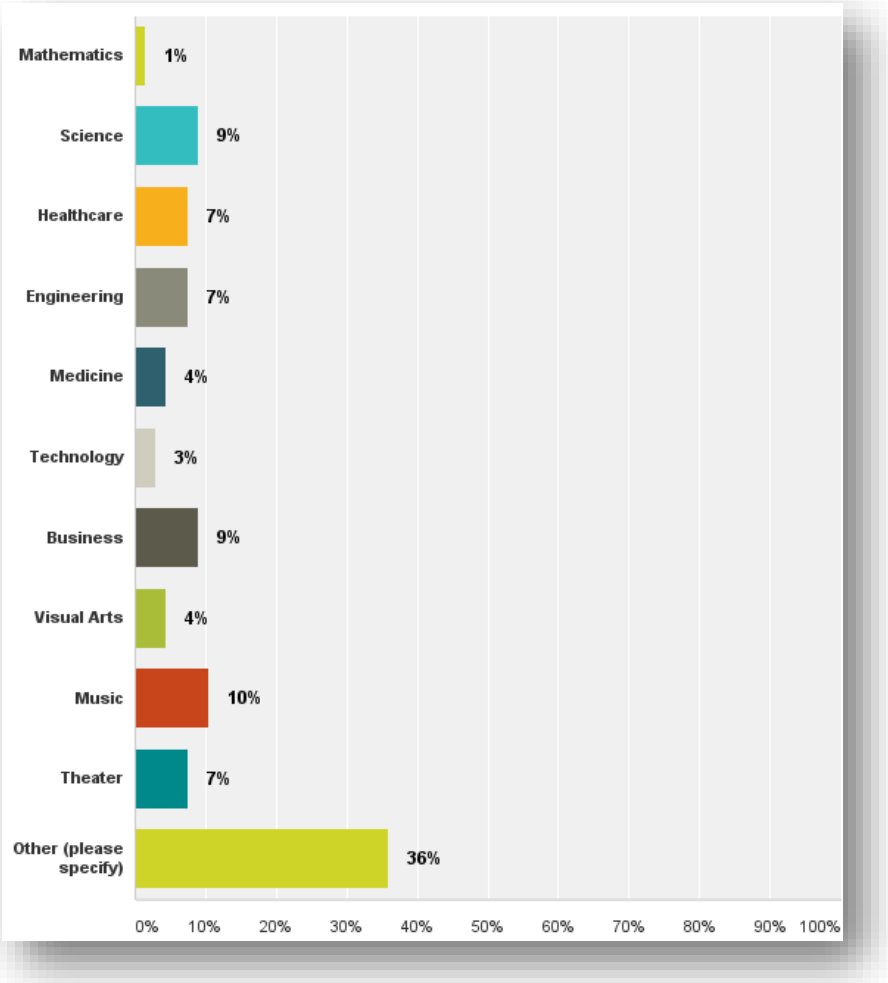
80% of respondents to this survey have a Baccalaureate degree or higher. Of those who do not indicate completing higher education, they indicate a wide range of interests and professional backgrounds. (Figure D).

Figure D: Education Level of Respondents:



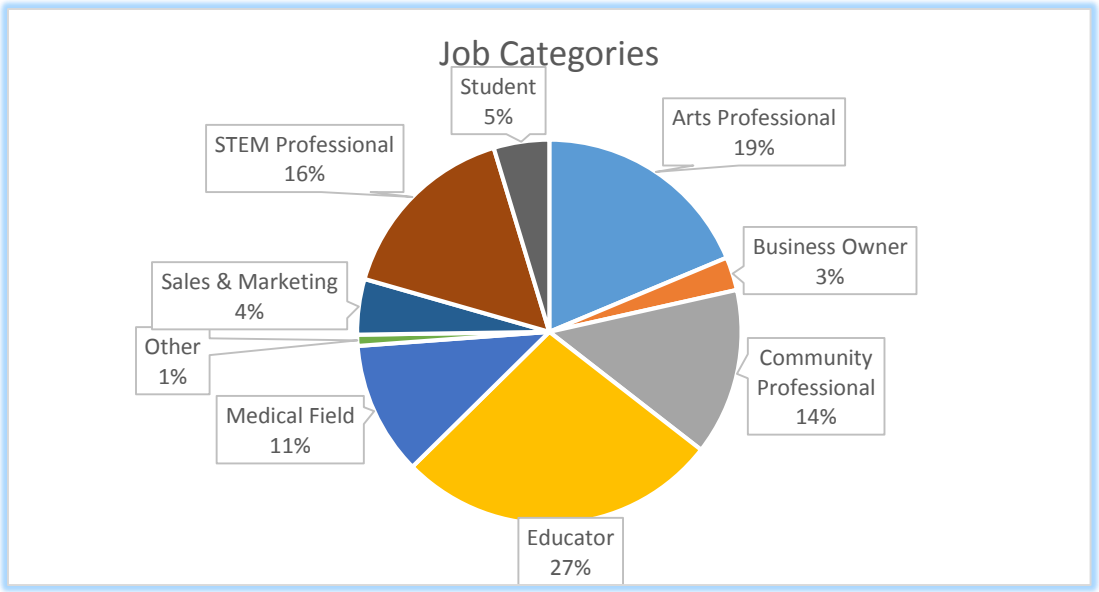
64% of respondents to this survey identified as being part of the STEM or arts fields. (For the purposes of this survey, those involved in medicine/healthcare are considered part of the science discipline). Of the 36% of those that identify as "Other," 13 of those respondents (54%) were professional educators or public school educational administrators who did not identify themselves as being part of STEM or arts disciplines. The other 9 respondents came from such diverse backgrounds as Theology, Community and Regional Planning, Social Work and Communications. These respondents came mostly from secondary sharing of the survey by those who received the initial requests. (Figure E)

Figure E: Respondent's Original Field of Study:



When asked to categorize themselves in regards to their professions, a broader picture began to emerge because respondents could identify themselves as more than one category. (For example, a Music or Theater educator could identify themselves as an Arts Professional and an Educator. A Science teacher could identify themselves as both a STEM professional and an educator and so on. Because of this ability to align with multiple categories, the overall demographic picture of the survey becomes clear: the largest percentage of survey takers identify themselves primarily as educators (27%) followed by Arts professionals (19%) and STEM professionals (16%)(Figure F).

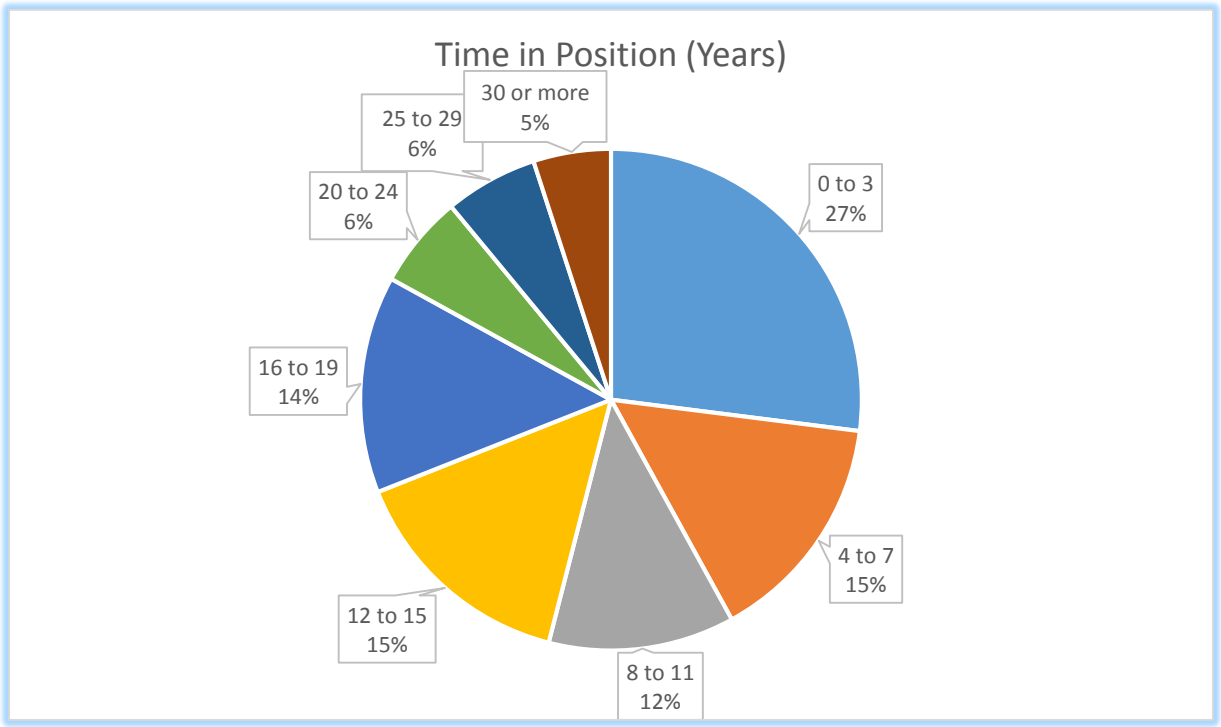
Figure F: Describe your profession:



The final question regarding demographics is intended to measure the stability of the sample regarding how long they have practiced their current vocation. According to the Bureau of Labor statistics, the average job tenure is 4.7 years for men and 4.5 years for women (Bureau of

Labor Statistics 2014). Respondents to this survey show a much more stable work life than average with only 42% of respondents being in their position less than 7 years. Fifty-eight percent of those responding have been in their profession 8 years or more which shows a level of professionalism and care about the field that they work in (Figure G).

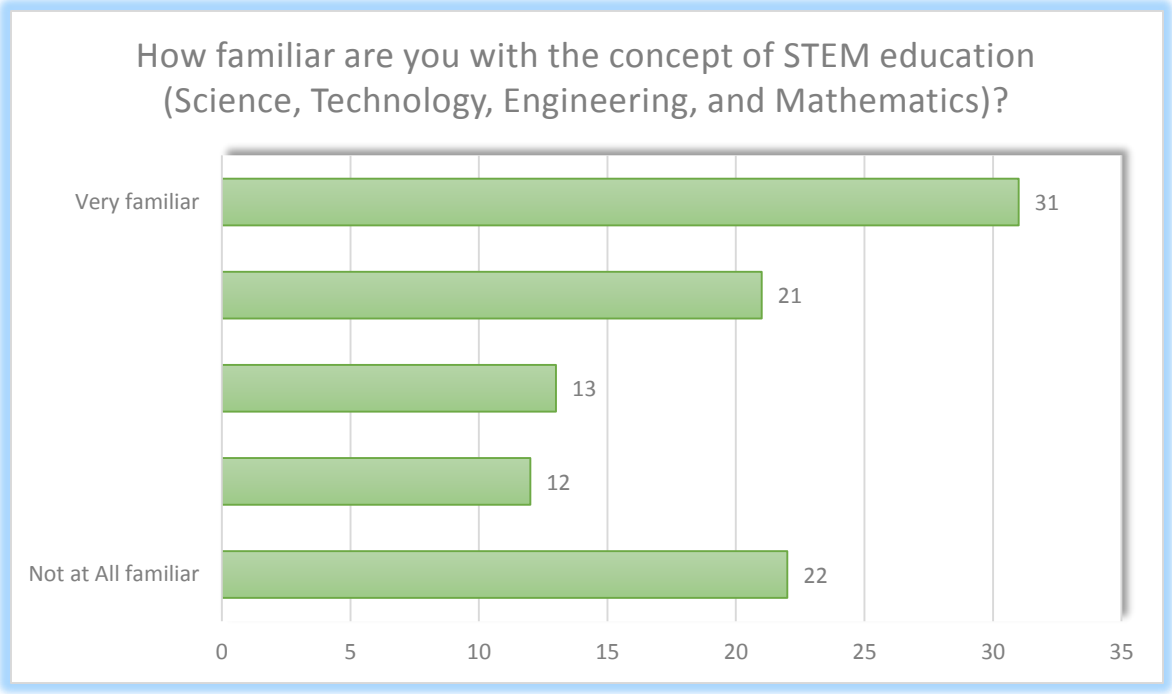
Figure G: How long have you been in your current position?



STEM Education

Respondents were asked about their knowledge of STEM education, how that education integrated itself into their daily lives, and to what extent their knowledge of STEM played into their current field of study or profession. First, they were asked about the concept of STEM education and how familiar they were with it on a 5 to 1 rating scale with 5 being very familiar to 1 being not at all familiar. The breakdown of responses was as follows:

Figure H: How familiar are you with the concept of STEM Education?

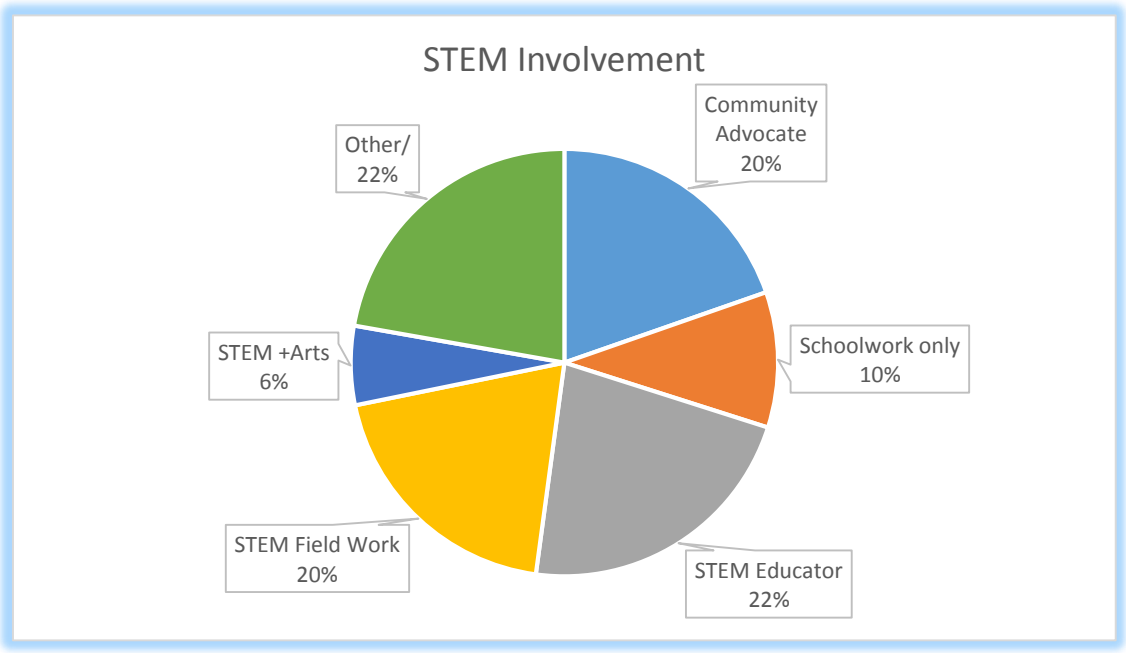


This breakdown is somewhat surprising given the amount of attention in the academic community that is being given to STEM education. Given that the average age of respondents is greater than 40, this sample shows that many outside of the academic community are not aware of the current push in both educational and political circles for increases in STEM education or the projected shortage in STEM related employees. Of those people answering the survey, 27% of respondents identified themselves as educators, and another 25% of people (non-educators) considered themselves as "Familiar," or "Very Familiar," with STEM education which is barely more than half the sample (52%).

When asked to describe the capacity in which they are involved in the STEM fields 20% of respondents identified themselves as working directly in the STEM fields, while 22% identified themselves as being STEM educators. **(Figure I)**. Another 6% reported being involved in both

the STEM and Arts fields combined. This group of people work primarily in the arts, but report using large amounts of technology in their professions either to teach or to create. Of those who did not report direct involvement in STEM, some were categorized as a community advocate meaning that while not working directly in a STEM field, they reported supporting STEM education or the STEM disciplines in various forms. The rest of the survey respondents (22%) reported having little to no current involvement in STEM disciplines and were therefore categorized as "Other/None."

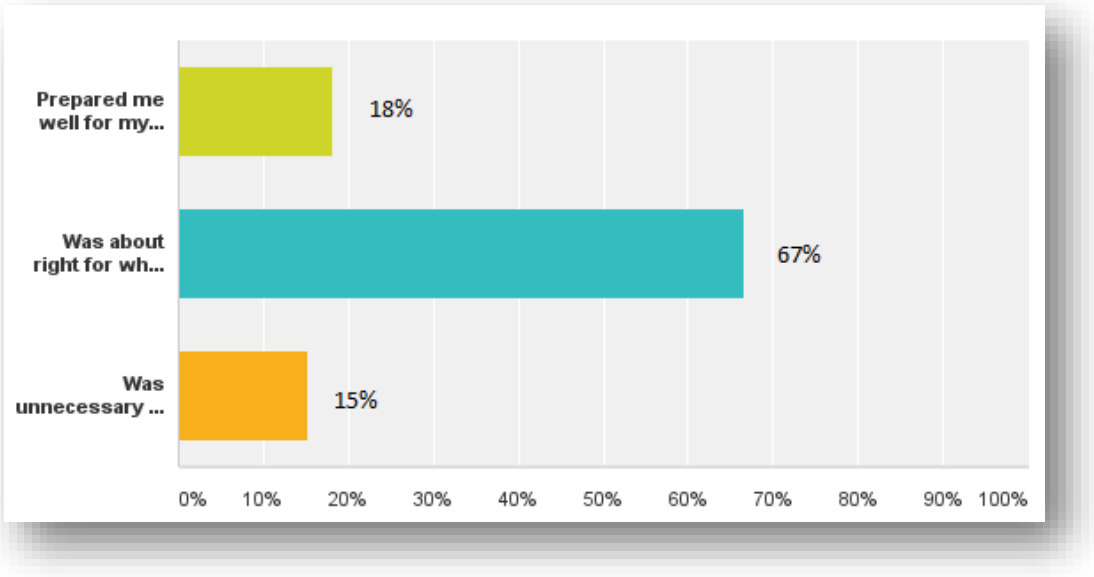
Figure I: In what capacity are you involved in the STEM fields?



The final question of this subset asked the all-important question in today's educational environment of "How well did your STEM education prepare you for your current profession?" The purpose of this question was to check perception of relevance. Many people (students and parents included) often question how relevant a child's education is that they are receiving and

whether it prepare them for the professional world. Most of the respondents surveyed thought that their education was correct for what they would need to succeed professionally (85% total). Still, 15% of respondents did not see the necessity of receiving the STEM education that they did. **(Figure J)** The question of making STEM education relevant, especially to women and minorities is one of the chief concerns of those currently advocating for increased STEM education (Feller 2010)

Figure J: How well did your STEM education prepare you for your professional life?:

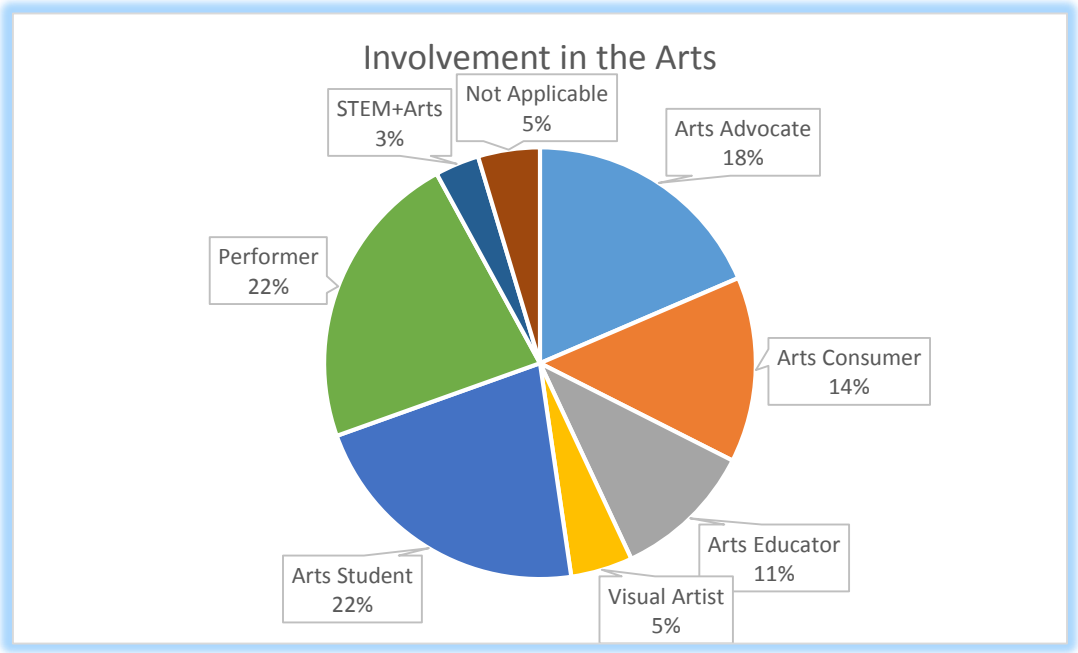


Arts Education

The next set of questions dealt with people's perceptions of their own arts education. How they felt about it, whether it was germane to their professional life in later years and whether they still participated in the arts in some form today. Of those who professed involvement in the

arts, most described themselves as students of the arts from an early age which then blossomed into being an artist in one form or another either through hobby or as a profession. For example, most survey respondents identified themselves in multiple areas as being a performer *and* an educator, or a student (current or former) *and* a consumer. Many in more than two areas. **(Figure K)** This shows how the arts has a broad reach to many people from different walks of life. When one compares the STEM question of involvement to the arts question of involvement, **(Figure I vs. Figure K)** one can see that people generally perceive the arts as more accessible. Whereas 22% of respondents did not see themselves as being involved in STEM in their current situations, only 5% would say the same for the arts.

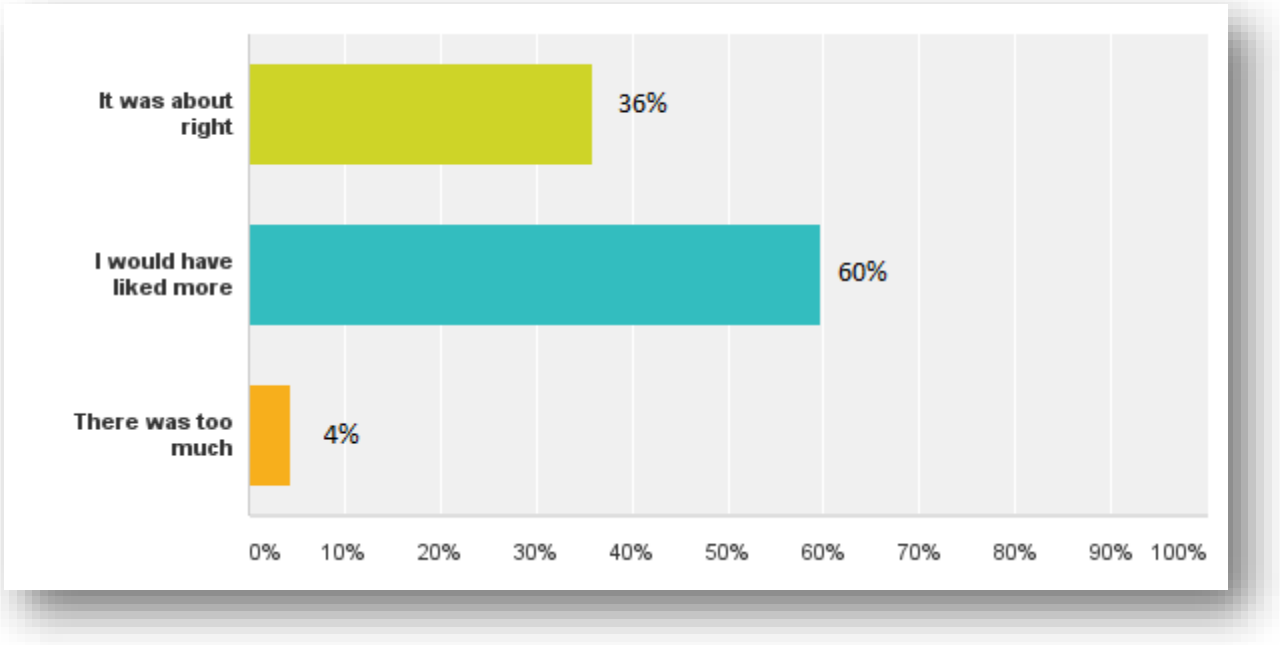
Figure K: How would you describe your current involvement in the arts?



Survey respondents also expressed a desire for more arts education in their traditional schooling. When asked about the arts education that they received K-12, the response was overwhelmingly positive. 36% of respondents said that the arts education they received was

"about right," while 60% said that they "would have liked more," leaving only 4% thinking that their K-12 arts education was unnecessary or frivolous. **(Figure L)**

Figure L: How would you describe the arts education you received in your K-12 schooling?



Perceptions of Need

When school programs come on the chopping block, one of the first questions that educators must often answer is how necessary their program is. In my own undergraduate training, we had a unit on how to advocate and defend our programs against budget cuts or against being eliminated altogether. Unfortunately, arts programs are often the first to fall under scrutiny when budgets run tight. In continuing with the study of public and professional perception, I wanted to know how respondents felt about how STEM education and arts education prepared them both for college and professional life.

In comparing the perceptions of arts education and STEM education as being necessary college preparatory courses, STEM courses rated higher overall among respondents as being necessary to the college bound student (**FiguresM&N**):

Figure M: How important is Arts Education for today's college bound student to be successful?

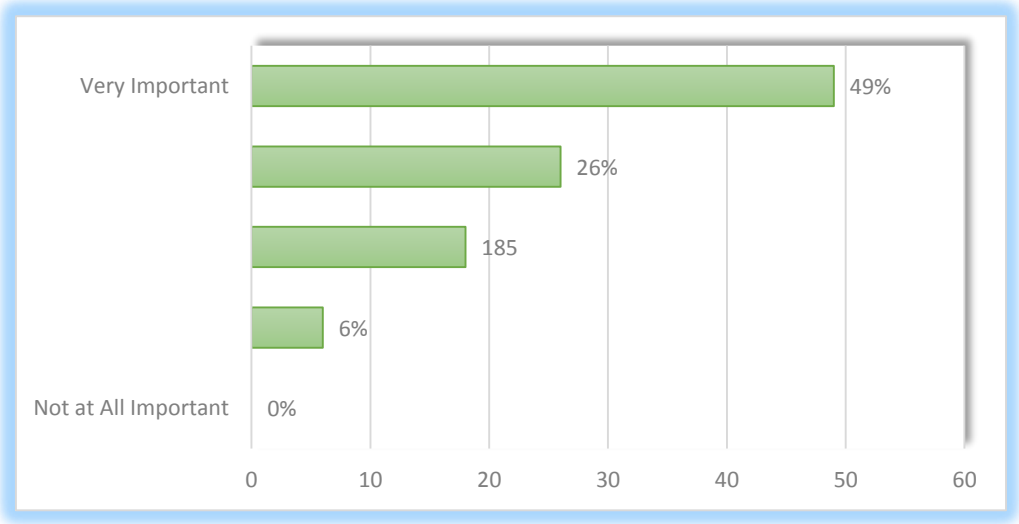
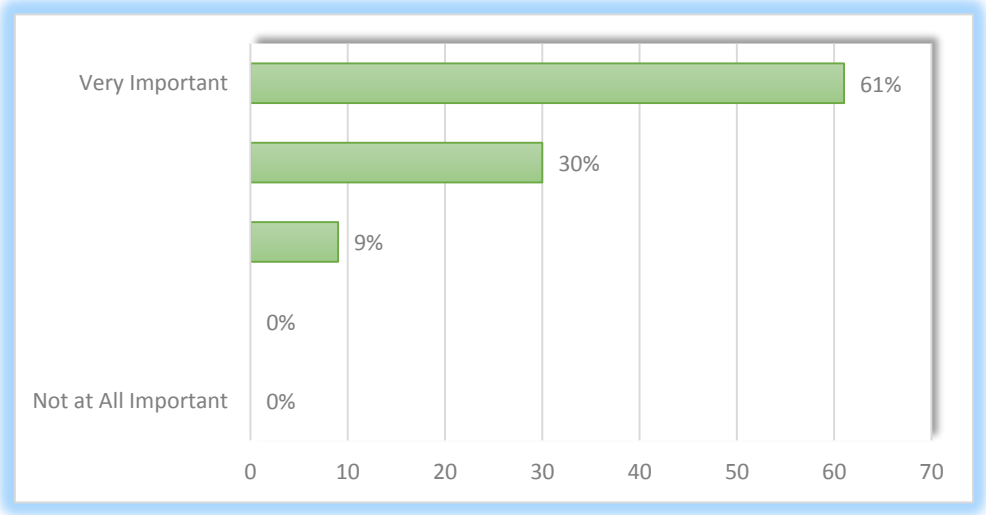


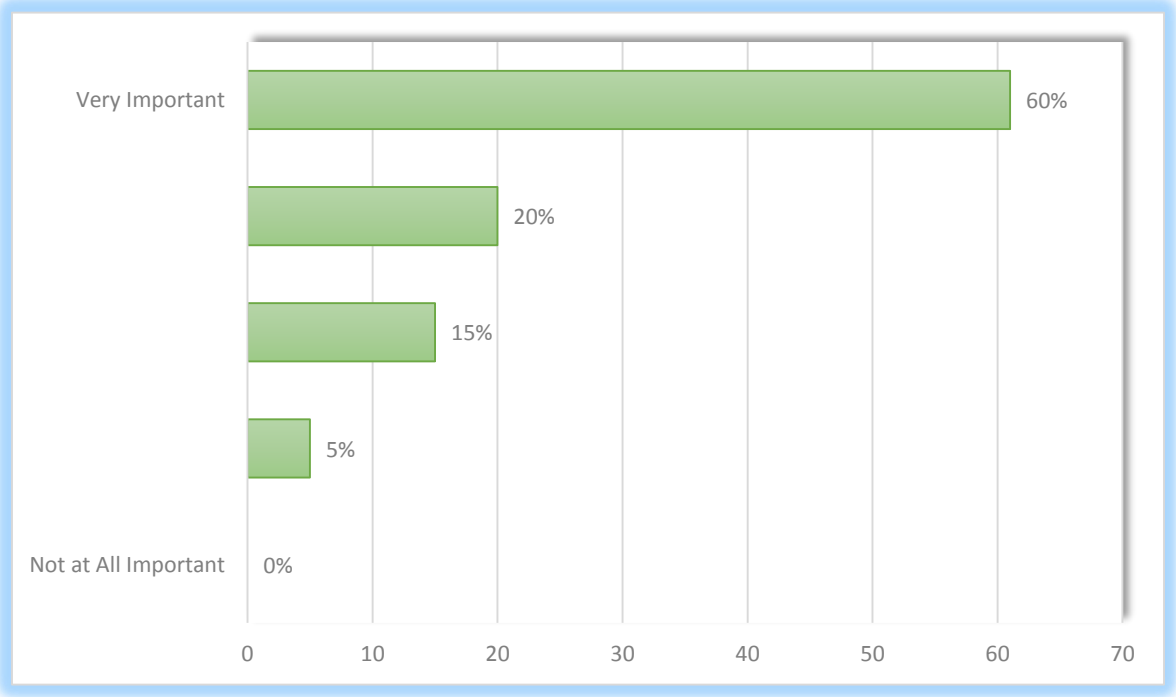
Figure N: How important is STEM Education for today's college bound student to be successful?



The desire to have the STEM disciplines remain central to our core education is very strong. Overall, respondents indicated the desire for students to succeed in the STEM disciplines as

being more necessary to future success than the desire for success in the arts. However, 95% of respondents still see arts education as being at least somewhat important over all (**Figure O**):

Figure O: How important is arts education in today's society?



The arts is usually known as a very personal experience. Whether people consider themselves to be artists or consumers, the arts affects us all in different ways. Some use the arts as enrichment for the soul, others use it as an escape from their daily lives. The purpose of **Figure P and Figure Q** was to find out how they perceived the arts operating in their daily personal and professional lives, and then to compare that to how they perceived the STEM disciplines working in their personal and professional lives.

Figure P: How does arts participation influence your daily life? (check all that apply):

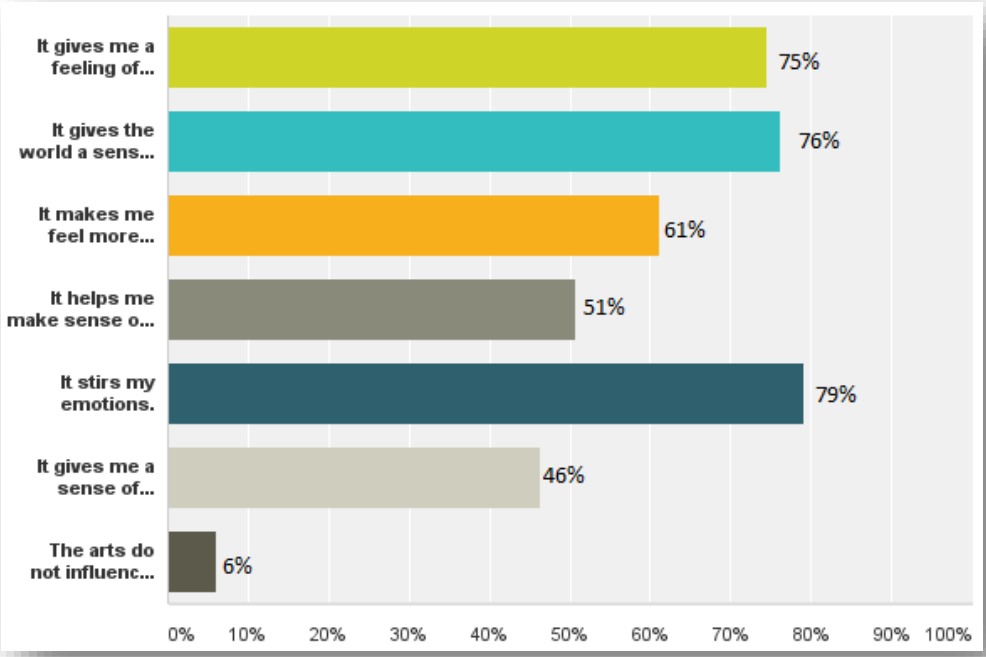
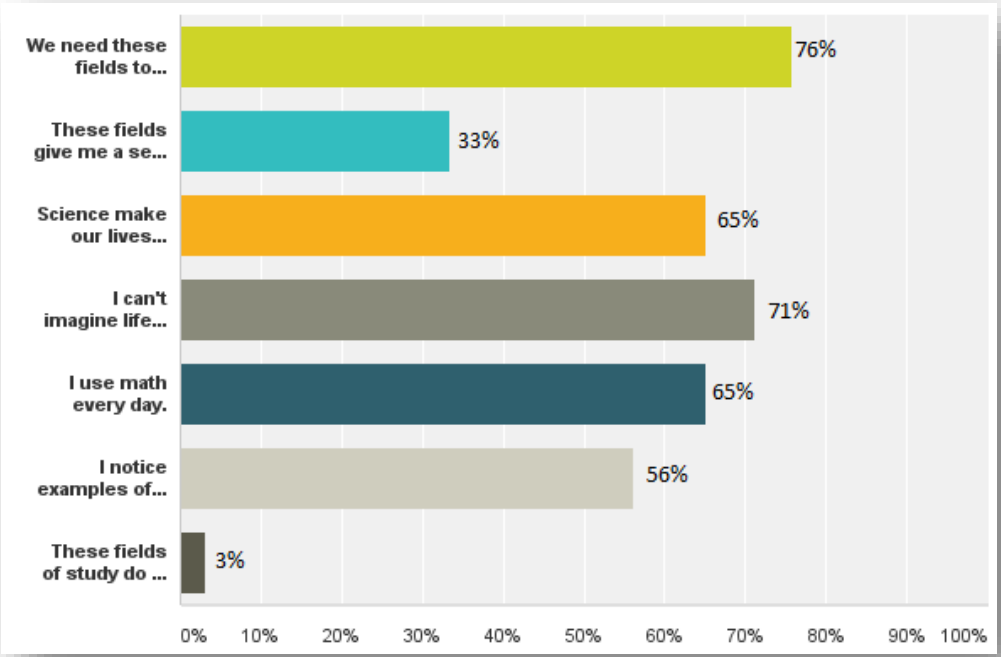


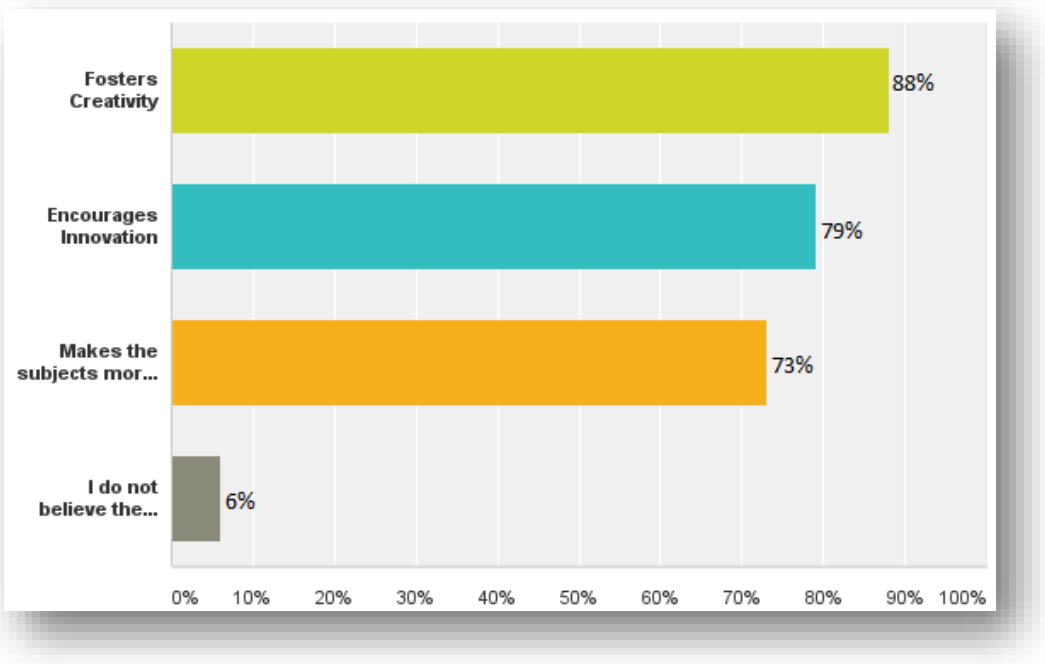
Figure Q: How do Science, Technology, Engineering and Math influence your daily life?



In comparing the two charts, it is notable that more positive affirmations were given to the arts than to the STEM disciplines. However, the answers to the arts question are more tied to emotional rather than concrete responses, whereas the STEM questions leaned more to the concrete.

Finally, respondents were asked about how STEM or the arts was an influence on their daily lives as well as their thoughts about integrating the arts into the STEM disciplines. This portion of the survey comes from the thought that as a common experience, everyone at one time or other during school asked themselves or their teachers why they were taking a particular class and how they would use that information in the future. The perception of need of both the arts and the STEM classes tells us a lot about how the public sees our education system as a whole. One school of thought is that integrating the arts into the STEM disciplines is one way of many to increase drive and interest in these subject areas. Others believe that the arts have their own intrinsic value and therefore should always stand on their own. When asked why they thought the arts and STEM might be a good fit, a wide range of responses was seen (**Figure R**):

Figure R: Integrating the Arts would benefit STEM because:



Respondents to this question had a lot of good input about why they thought the arts and STEM were a good fit. Comments from those responding to the positive thought that STEM+arts integration makes the STEM disciplines more approachable and easier for students to understand as well as helping with problem-solving skills. Those who were not in favor of combining the subject areas thought that STEM and the arts should be more inclusive and participatory rather than being artificially separated or again that the two areas should stand on their own merits.

Respondents were also more divided when posed with questions regarding how best to foster creativity and innovation (**Figures S & T**):

Figure S: The arts are necessary for fostering creativity and innovation.

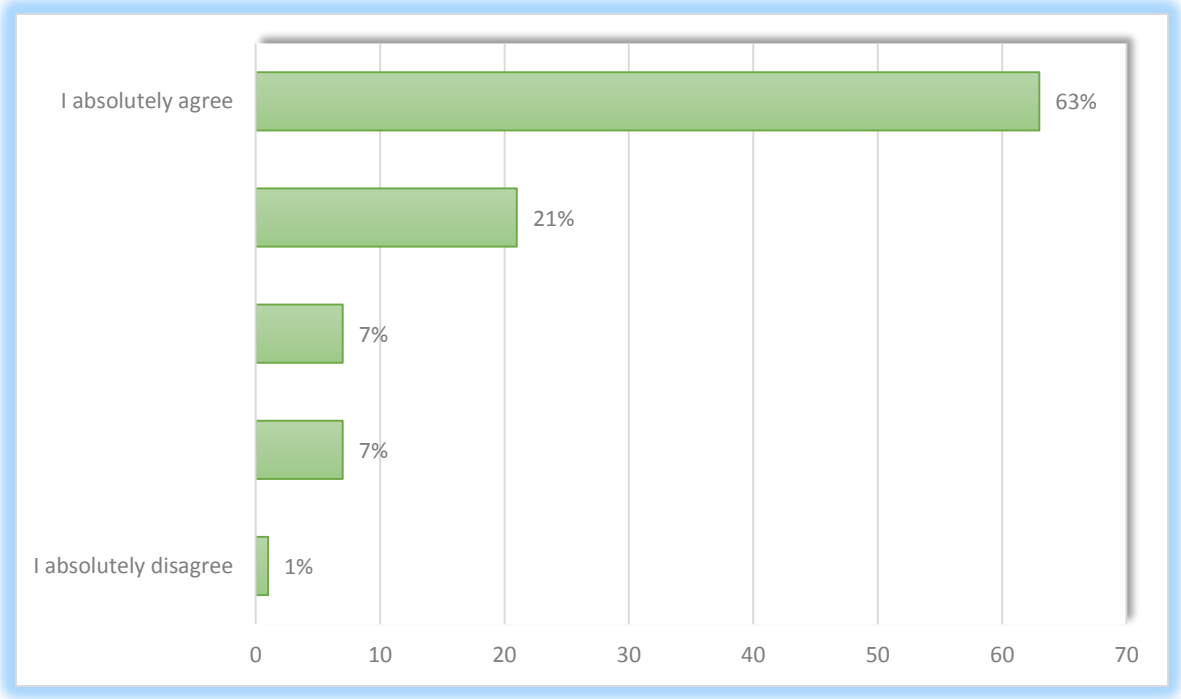
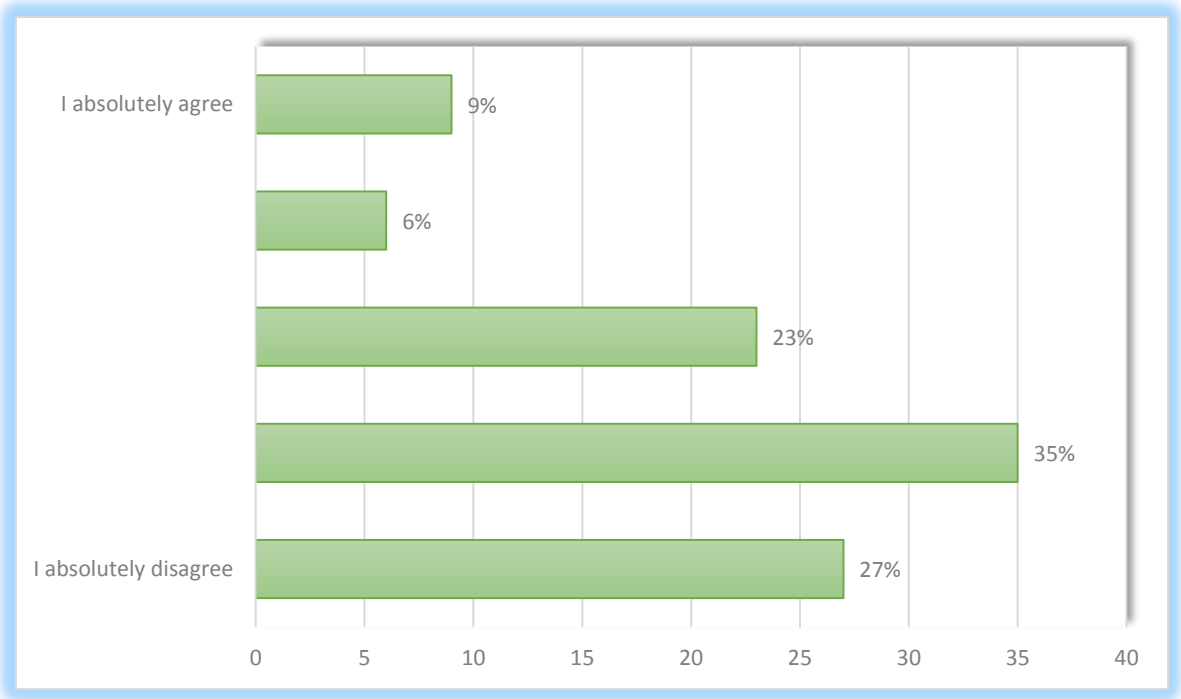


Figure T: The STEM disciplines give ample opportunity for expressing creativity and innovation:



Conclusion

This paper set out to *investigate the question of whether professionals in working in the Arts and STEM fields view the current arts integration debate as being critical to fostering creativity and innovation in their own disciplines and whether the general public views the integration of arts and STEM necessary.* Through the research completed, it was shown that while most educators surveyed agree with the concept of the integration of arts and STEM, many do not see it as completely feasible in today's educational environment. Reinforcement of various educational concepts do happen through curricular integration, but a full reworking of curriculum to include arts integration in the STEM disciplines is more than most school systems have time or resources for.

The question investigated by this thesis as to whether professionals working in the STEM fields and the arts view the current arts integration debate as being critical to fostering creativity and innovation in their own disciplines and in the workplace is still in need of further research. On the one hand, many people agree that the study of the arts as a part of a well-rounded education helps with higher-order thinking, problem solving, teamwork, and a host of other benefits that will create a more grounded individual when they enter the work place. On the other hand, many also hold the view that the STEM disciplines require critical thinking skills, creativity, teamwork, and problem solving skills all on their own. Arts integration therefore becomes an enhancement, not a requirement.

When looking at the overall characteristics of those who took the survey, one can see that this survey ended up being heavily weighted in the favor of those who are professional educators and those involved in the arts community. In the case of this survey, professional networking

was the primary factor in choosing the subjects who would be able and/or willing to take a survey on this topic. Many respondents did ask about sharing the survey with an outside circle of influence, but response from them seemed to be minimal (about 15% of respondents).

As stated before, most of the survey respondents consider themselves to be a part of either the performing arts or the education field or in some cases, both. This may have led to more positive responses regarding the inclusion of the arts in the STEM curriculums as well. When looking at non-arts respondents as a group, their answers were split about 80/20 as to whether the STEM disciplines would benefit from arts integration with 80% being for and 20% being against. Those who were on the positive side of arts integration into the STEM disciplines also expressed their opinions:

- It makes STEM more approachable
- STEM and the arts (both) should be more inclusive and participatory. They are artificially separated in academics.

Some of the reasons given for why arts integration was not always the best idea include:

- The arts should stand on their own and be “arts for art’s sake.”
- There is too much curriculum in the Math, science and computer fields already that needs to be taught, (adding the arts) would bring too much into an already crowded classroom.
- While helping the “whole person,” concept, it should not be a requirement.

When one looks at the overall results of the survey, one of the more alarming pieces of information that becomes evident is the lack of information that some non-educators have about STEM education in general. Even with the significant investment in resources of the National Science Foundation, NASA, the STEM- Ed Coalition, and many others in the STEM advocacy fields, many people still remain largely unaware of the importance of STEM education

and the gap in STEM-related jobs that we will be facing in the next 20-30 years. It is not for a lack of hard work…but most of the efforts to promote the importance of STEM education have been directed at educators and people who work in the STEM fields. In other words, the ones who already know how important it is that we continue to make advances in the STEM fields as well as in creativity and innovation.

As a result of the survey, many assumptions of the hypothesis were largely proven:

- 86% of those who reported being involved in a STEM-oriented career also reported having a strong background in the arts through school or other outside participation

- 94% of those involved in STEM-oriented careers reported themselves as still being an avid arts supporter, either as a consumer or patron

- 94% of respondents who work in the STEM fields also rated the arts experience they received throughout their youth as being highly important in their personal and professional development.

- More arts-related education during formative years may lead to higher creative jobs and more professional satisfaction.

What was most interesting was the differences between the original hypotheses and what reality is from those who work in the education field:

- Most of those who identified themselves as STEM area educators (80%) were against *required* arts integration due to the sheer amount of content that they already had to teach

- Most of those who identified themselves as arts educators (66%) believed that the arts should exist on its own as a content area and integration into other subject areas should not be "forced."
- While many educators were against the idea of *requiring* integration, they would not be against cross-curricular collaborations and reported that these types of collaborations already happen frequently.
- Those who identified themselves as educational administrators (6% of total survey sample) view STEM + arts integration (and other collaborations between subject areas) as yet another facet of 21st century education.

After analyzing the results of this survey, the following conclusions may be drawn:

- People from all walks of life (not just professionals) perceive the arts as important to their development both personally and professionally.
- The arts give people a greater sense of self and of self-worth.
- Professionals who work to promote STEM education have a great love of the arts either from past experience or from existing enjoyment (or both).
- While arts professionals are not against collaborations with other core subject areas, most believe that it should not be made necessary or required and that the arts should stand alone as its own discipline complete with evaluations and national standards.
- Most STEM professionals believe that while integrating the arts might help to boost interest in their subject areas, it is not the only way to teach and creativity and innovation can come from multiple sources, not just the arts.
- Survey participants reported STEM and arts education integrating themselves into other subject areas without any outside influence (i.e. Math helped one student understand

patterns in foreign language; A theater class gave a respondent a better understanding of history).

Bringing the Arts and the STEM disciplines (and other subjects for that matter) together is a challenge that future educators and arts administrators will have to face in the future. The largest hurdle facing arts integration is the current version of "No Child Left Behind." With the current educational trend of "teaching to the test," schools are often not allotted time or budget to allow for true curricular integration of the arts into the core subject areas. However, the recent passage of *Every Child Achieves*, in July of 2015 should help in this regard as it has placed the arts among the common core standard of academic subjects.

Another hurdle faced by integration advocates is in the shortage of arts-integrated teachers. The argument that many non-arts teachers are not comfortable teaching in an arts-related manner comes into play when core subject classroom teachers are asked to integrate an arts perspective into their existing curriculum. The hiring of an arts integration specialist while worthwhile is often not on most school's lists of priorities due to the rigors of a full curriculum day as well as budget constraints. In theory, classroom training and development for teachers of all age levels and subject areas should be available to allow for the exchange of ideas and teaching methods that can integrate arts education into their subject area. Conversely, arts educators should have a fundamental knowledge of other subject areas so that they can introduce their types of learning into the arts classroom as well. This should be done for no other reason than to help foster and enable different student's learning styles.

If educators were allowed to teach using more creative teaching methods and introduce different artistic concepts in their instructional design, students may begin to find different interests and passions in their subject areas as well as creative ways to view the world.

Educational Policy Implications

"In the push for quality math, science, technical, humanities, and other programs, please be sure that the arts are not ignored or pushed to one side. Provide your political support for the total curriculum. The arts enrich all of us." –Dr. Richard Miller, Executive Director American Association of School Administrators

Currently, there are no formalized educational policies on a national level regarding the integration of the arts into STEM curriculum. Though studies have been done on the local level, they have not been large enough to influence a national precedence. In one case, an arts-intensive organization in Los Angeles called ICA (Inner-City Arts) has formed a partnership with the Los Angeles Unified School District where specialists come into the schools and work directly with teachers to help them develop curricula that will enhance and integrate the arts into the standard curriculum of their classroom (Peppler 2015). This experimental program has made excellent strides in cross-curricular arts enhancement, particularly for English Language Learner students who might struggle with ordinary classroom instruction due to the language barrier.

The John F. Kennedy Center for the Performing Arts in Washington D.C. currently boasts the closest guide to a national arts integration policy with its Changing Education through the Arts (CETA) program. Though it currently serves teachers primarily in Maryland, Virginia and the

District of Columbia, CETA offers a large amount of resources for teachers nationwide who are interested in fostering arts integration programs in their own schools (https://artsedge.kennedy-center.org). Much like the Los Angeles program, CETA focuses on professional learning communities, ongoing assessment and evaluation, and whole school implementation to make arts integration a reality in their partner schools.

In order to make arts integration a reality nationwide, it will be necessary for professional organizations that create arts standards such as the National Association for Music Education (NafME) to have more interactions with policy makers and national standards boards. The passage of the *Every Child Achieves* act on July 16, 2015 by a bi-partisan group of Congressman has now cemented music and the arts as core subjects in the national education framework (nafme.org 2015). A positive step in the right direction.

Study Limitations and Future Research

The debate over whether STEM + arts will become the norm in K-12 and post-secondary education is yet to be seen. In general, research shows that those who advocate for improving Science, Technology, Engineering and Math standards in our schools need to do more to make the public aware of advancements in STEM education (Henricksen 2014). While the educational movements are firmly in place to prepare students for twenty-first century learning, those outside of the educational fields may not be aware of the gaps in education and in STEM-related jobs that we will be facing in the next twenty years.

The gap in technology and science education is one of the chief concerns amongst politicians and educators and we are constantly outpaced by smaller, European nations like Poland and

Finland (Palveeva 2014). With all of the "teaching to the test," and complaints of current educators of how this discourages classroom creativity, there are many who still do a remarkable job of creating learning situations that reach all of the different types of learners that they are charged with teaching. Creating a culture of innovation and creativity in their classrooms is what most educators still strive to foster.

The arts, while important in many student's lives, is not the only way to encourage creativity and innovation in the classroom. While the integration of the arts into outside subject areas such as math, science and even history may help some students learn better, this may be a function of individual learning style rather than purely one of arts integration. Most of the arts educators that I have talked to throughout the course of my writing believe that the arts should not apologize for itself and should be made to stand alone. The recent adoption of the National Core Arts standards (National Coalition for Core Arts Standards 2014) and with many states taking the lead (including my home state of Nebraska who adopted their fine arts standards in March of 2014) show that arts educators are serious in showing that the arts is a core subject area, no different from STEM or English or history.

Enjoyment and advancement of the fine arts is crucial to intellectual stimulation, creative problem solving and living fuller, happier lives. A fine arts degree is no longer the "useless piece of paper," that many of our parents once thought it was. A recent study from the Wall Street Journal finds that people who receive Bachelor of Fine Arts degrees have a median income of $42,000 per year. When those students go on to get their Masters of Fine Arts degrees (as many do), their median income becomes $50,000 per year which is slightly better than those who have their degrees in psychology and social work (Grant 2013). The debate is still open on

this, however, as some of the top financial magazines such as Forbes and Kiplingers still list degrees in music or art history among the lowest paid majors (Crotty 2014).

It is therefore no surprise that many companies on the forefront of creating new or improving existing technologies are actively seeking out the graduate with the liberal arts or fine arts degree. Especially when one considers the fact that 1/3 of Fortune 500 CEO's hold those types of degrees themselves (Segran 2014). Those with fine arts degrees may see technology from a new and different perspective. They are also often uniquely positioned to put their company's technology into plain language that is easier for outside investors or consumers to understand.

The combination of the fine arts and STEM will never be completely one-sided. Both can co-exist and use each other's techniques to inspire and challenge their students. Both can also exist on their own with their own sets of challenges, creative strategies, and ways to measure and assess their successes and failures. They should not be artificially kept apart, not should they be made to integrate when it is not necessary. The arts and STEM should both inspire their students to create a better world.

Appendix A

Sample of Survey used in data gathering in this thesis

STEM + Arts in Education

1. What is your age?

- 17 or younger
- 18-20
- 21-29
- 30-39
- 40-49
- 50-59
- 60 or older

2. What is your gender?

- Female
- Male

3. What is the highest level of school you have completed or the highest degree you have received?

- Less than high school degree
- High school degree or equivalent (e.g., GED)
- Some college but no degree
- Associate degree
- Bachelor degree
- Graduate degree

4. Which of the following best describes the field in which you received your highest degree?

- Computing
- Engineering
- Dance
- Visual Arts
- Medicine
- Business
- Science

- Mathematics
- Technology
- Healthcare
- Music
- Theater
- Other (please specify)

5. Describe your profession.

6. About how long have you been in your current position?

Years

7. How familiar are you with the concept of STEM education (Science, Technology, Engineering, and Mathematics)?

Very familiar

Very familiar

8. Which of these options best explains your involvement in STEM? (you may choose more than one answer)

- STEM educator.
- Work in the field. (Laboratory, Professional, Hands On, etc.)
- Engineer.
- Technologist. (Computers and other technology)
- Scientist.
- Mathematician.
- I am an advocate for STEM and STEM education.
- None of these describe me.

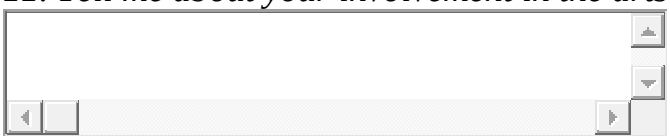
Comments:

9. Tell me about your involvement in the STEM disciplines:

10. The education I received in Science, Technology, Engineering and Math in my K-12 schooling (choose only one)

- Prepared me well for my professional life
- Was about right for what I needed to succeed professionally
- Was unnecessary for my professional life

11. Tell me about your involvement in the arts:



12. Regarding the arts education I received throughout traditional K-12 schooling, (choose only one)

- It was about right
- I would have liked more
- There was too much

Comments:

13. Which of these options best describes your involvement in the Arts. (you may choose more than one answer)

- Arts producer/creator. (Including but not limited to: visual art, theater, film, dance or music)
- Arts events regularly as a consumer. (Including but not limited to: visual art, theater, film, or music)
- Arts supporter/donor. (I give monetary or other gifts to arts organizations)
- Arts performer (professional or amateur).
- Arts Educator
- None of these describe me.

Other (please specify)

14. How important is Arts Education for today's college bound student to be successful?

Very important Unimportant

Comments:

15. How important is Science, Technology, Engineering, and Math (STEM) education for today's college bound student to be successful?

Very important Unimportant

16. How does arts participation influence your daily life? (check all that apply)

- ☐ It gives me a feeling of enrichment.
- ☐ It gives the world a sense of beauty.
- ☐ It makes me feel more human.
- ☐ It helps me make sense of the world around me.
- ☐ It stirs my emotions.
- ☐ It gives me a sense of purpose.
- ☐ The arts do not influence my daily life much.

Comments:

17. How does Science, Technology, Engineering and Math influence your daily life? (check all that apply)

- ☐ We need these fields to advance our understanding of the world.
- ☐ These fields give me a sense of enrichment.
- ☐ Science make our lives better as a whole.
- ☐ I can't imagine life without technology.
- ☐ I use math every day.
- ☐ I notice examples of engineering everyday.
- ☐ These fields of study do not influence my daily life much.

Comments:

18. In your opinion, how important is arts education in today's society?

Highly important Unimportant

○ Highly important ○ ○ ○ ○ Unimportant

19. Integrating the Arts would benefit STEM because (check all that apply)

- ☐ Fosters Creativity
- ☐ Encourages Innovation
- ☐ Makes the subjects more engaging
- ☐ I do not believe the STEM disciplines should have the arts as a part of the curriculum

Other (please specify)

20. I do not think the arts should be incorporated in the STEM disciplines because (check all that apply)

- ☐ The arts can be frivilous
- ☐ They take away focus from core subject areas like math, science and history
- ☐ STEM disciplines are concrete, arts disciplines are random
- ☐ I believe the arts should be integrated into the STEM disciplines

Other (please specify)

21. I believe the arts are necessary for fostering creativity and innovation.

○ This is absolutely true ○ ○ ○ ○ This is absolutely not true

Comment

22. I believe the STEM subjects require plenty of creativity on their own without having the arts integrated into them.

○ This is absolutely true ○ ○ ○ ○ This is absolutely not true

Other (please specify)

23. Other comments?

Bibliography

Adobe Create. *State of Create Study.* Statistics, Washington DC: US Government, 2012.

Beal, Stephen. *Turn STEM to STEAM:Why Science Needs the Arts.* Jun 11, 2013. http://www.huffingtonpost.com/stephen-beal/turn-stem-to-steam_b_3424356.html (accessed Oct 17, 2014).

Beard, Katherine. *US News and World Report.* November 13, 2013. http://www.usnews.com/news/articles/2013/11/13/behind-americas-decline-in-math-science-and-technology (accessed December 7, 2014).

Bidwell, Allie. "Report: STEM job Market Much Larger Than Previously Thought." *US News & World Report*, Feb 5, 2014: 31-32.

Bort, Julie. *Business Insider.com.* July 15, 2013. http://www.businessinsider.com/how-tech-companies-boost-creativity-2013-7 (accessed February 07, 2015).

Boy, Guy A. "From STEM to STEAM: Toward a Human Centered Education." *Eurpoean Conference on Cognitive Ergonomics.* Toulouse, France: NASA, 2013. 1-7.

Brady, Justin. "STEM is incredibly valuable, but if we want the best innovators we must teach the arts." *Washington Post*, Sept 5, 2014: 31-32.

Bureau of Labor Statistics. *Employee Tenure in 2014.* News Release, Washington DC: US Department of Labor, 2014.

Catmull, Ed. *Creativity Inc: Overcoming the Unseen Forces that Stand in the Way of True Insiration.* New York: Random House, 2014.

Congress, US. *STEM EDUCATION IN ACTION: Learning Today...Leading Tomorrow.* Transcript, Washington DC: US Govt., 2011.

Crotty, James Marshall. *Forbes.* November 28, 2014. http://www.forbes.com/sites/jamesmarshallcrotty/2014/11/28/10-worst-paying-college-majors-part-2/2/ (accessed August 7, 2015).

Doss, Henry. *The Innovation Curriculum: STEM, STEAM or SEA?* Sept 17, 2013. http://www.forbes.com/sites/henrydoss/2013/09/17/the-innovation-curriculum-stem-steam-or-sea/ (accessed Oct 9, 2014).

Duncan, Arne, interview by Andrea Mitchell. *Innovation and Technology, Panel 2* (May 28, 2013).

Feller, Angela Traurig and Rich. "Preparing Students for STEM Careers." *STEMCareer.com.* September 1, 2010. http://stemcareer.com/stemwpfolder/wp-content/uploads/2010/09/Preparing-Students-for-STEM-Careers-9-2-10.pdf (accessed April 30, 2015).

Gail Burnaford, Arnold Aprill, Cynthia Weiss. *Renaissance in the Classroom: Arts Integration and Meaningful Learning.* Abingdon, UK: Routledge, 2013.

Grant, Daniel. " A Fine Arts Degree Might Be a Better Choice than you think." *Wall Street Journal*, November 10, 2013: 23-24.

Henricksen, Danah. "Full STEAM Ahead: Creativity in Excellent STEM Teaching Practices." *The STEAM Journal*, 2014: 15-21.

Humanities, President's Committee on the Arts and. *Champions of Change: The Impact of the Arts on Learning.* Washington DC: Arts Education Partnership, 2012.

James Bequette, Marjorie Bequette. "A Place for Art and Design Education in the STEM Conversation." *Art Education* , 2012: 40-46.

Jim O'Neill, Kelly Pollock. "Education in the New Economy: STEM plus Arts." *St Louis Post-Dispatch*, July 15, 2014: 15.

Labov, Steve Olson & Jay. "STEM Learning is Everywhere: Summary of a Convocation on Building Learning Systems." *Teachers Advisory Council Program.* Washington DC: National Academies Press, 2014. 7-80.

Levetin, Daniel. "How to Solve Google's Crazy, Open-Ended Interview Questions." *Wired*, 08 22, 2014: 64-65.

Luke Rinne, Emma Gregory, Julia Yarmolinskaya, Mariale Hardiman. "Why Arts Integration Improves Long Term Retention of Content." *Jornal of the International Mind, Brain and Education Society*, 2011: 89-94.

nafme.org. *Senate Passes Every Child Achieves Act, with Music and Arts as Core Subjects, Intact.* July 16, 2015. http://www.nafme.org/senate-passes-every-child-achieves-act-with-music-and-arts-as-core-subjects-in-tact/ (accessed July 17, 2015).

National Center for Education Statistics. *Fast Facts/Teacher Trends.* Teacher demographics, Washington DC: US Department of Education, 2008.

National Coalition for Core Arts Standards. *http://www.nationalartsstandards.org.* June 1, 2014. http://www.nationalartsstandards.org/ (accessed June 22, 2015).

Palveeva, Emilia. *Artefact Group.* June 06, 2014. http://www.artefactgroup.com/content/civic-iq-alpha/ (accessed May 22, 2015).

Parker, Kristen. *A Young Picasso or Beethoven could be the next Edison.* Oct 23, 2013. http://msutoday.msu.edu/news/2013/a-young-picasso-or-beethoven-could-be-the-next-edison/ (accessed Aug 31, 2014).

Peppler, Kylie. *edpolicyinca.org.* March 10, 2015. http://www.edpolicyinca.org/blog/arts-integration-key-student-academic-achievement (accessed July 15, 2015).

Riley, Susan. *Pivot Point: At the Crossroads of STEM, STEAM and Arts Integration.* Dec 18, 2013. http://www.edutopia.org/blog/pivot-point-stem-steam-arts-integration-susan-riley (accessed Sept 30, 2014).

—. *Use Arts Integration to Enhance Common Core.* Dec 20, 2012. http://blog.artsusa.org/2012/12/20/use-arts-integration-to-enhance-common-core/ (accessed Nov 15, 2014).

Robinson, Sir Ken. "As Science Turns its Attention to Feeling." *Huffington Post*, January 13, 2012.

Sanders, Mark. "STEM, STEM Education, STEMmania." *The Technology Teacher*, 2009: 20-26.

Segran, Elizabeth. *Fastcompany.com.* August 28, 2014. http://www.fastcompany.com/3034947/the-future-of-work/why-top-tech-ceos-want-employees-with-liberal-arts-degrees (accessed June 20, 2015).

Tymas-Jones, Raymond. *STEM + A ≠ STEAM.* July 16, 2014. http://blog.artsusa.org/2014/07/16/stem-a-%E2%89%A0-steam/ (accessed Nov 2, 2014).

Vega, Vanessa. *Research-Based Practices for Engaging Students in STEM Learning.* Oct 31, 2012. http://www.edutopia.org/stw-college-career-stem-research (accessed Sept 09, 2014).

White House. *Educate to Innovate.* Report to the President, Washington DC: President's Council of Science and Technology, 2009.